9-1-2019

Collaborative trend on research publications: a new dimension in indexing

Tamizhchelvan M
The Gandhigram Rural Institute - Deemed to be University, Gandhigram, tamizhchelvan@gmail.com

Gopalakrishnan S
Madras Institute of Technology, Anna University, Chennai, gopallong@gmail.com

COLLABORATIVE TREND ON RESEARCH PUBLICATIONS: A NEW DIMENSION IN INDEXING

Dr. M. Tamizhchelvan
Deputy Librarian
The Gandhigram Rural Institute
(Deemed to be University)
Gandhigram – 624 302
tamizhchelvan@gmail.com

Dr. S. Gopalakrishnan
Assistant Librarian (Retd)
Madras Institute of Technology
Anna University
Chennai
gopallong@gmail.com

ABSTRACT

The collaboration is perceived as an effort in enhancing the capabilities and is also considered as a mechanism for information sharing. It is generally accepted that scientific collaboration is beneficial to both less advanced countries and highly industrialized countries. Normally collaborative coefficient, Degree of collaboration, modified collaborative coefficient, collaborative index were used to measure the collaborated papers. The collaborated papers reach and unreach index was identified in this study. Similarly, RF factors of authorship pattern of collaborated research publications were identified. Further, whether collaborated papers reach the user or solo research paper reach the user were analysed.

A new derived method of Measures of reach of scientific output was made using Reach percentage (RP); Reach Activity Index (RAI); Unreached/Reach Activity Index (URAI) and Unreached Activity Index (UAI). In order to identify the reach of the publications, the research publications of similar nature on a particular domain governed by the policy maker *were taken up for the study. In this study the Indian Institute of Management, Internationally well-known management institution, were taken up for the study with the opinion that these publications were reached globally. This study identified the factors that attributed for reach and richness of publications seems to be meaningful instead of taking citation alone has criteria to predict the value of the paper.*

Keywords: Scientometric indicators; Reach Factor; Reach Activity Index; Unreached Activity Index; Indian Institute of Management.

INTRODUCTION

Scientific collaboration is perceived as an effort in enhancing the scientific capabilities and is also considered as a mechanism for information sharing. It is generally accepted that scientific collaboration is beneficial to both less advanced countries and also to highly industrialized countries.

Many data analysis methods are employed during Scientometric analysis including co-authorship analysis, and citation analysis (i.e., papers or authors often cited in the cycle) Callon

(1986); Callon, Courtiaol & Laville (1991); He (1999); Leydesdorff (1997); Peters & Van Raan (1993). Few indexing techniques such as h index (Hirsch,2005); h2 index (Kosmulski, 2006); g index (Egghe, 2006); a index (Jin, 2006); Normalized h index (hnom)(Sidiropoulos, Katsaros, and Manolopoulos 2007); r Index (Jin et al, 2007a); ar index, (Jin, 2007b); e index (Zhang, 2009); hg index, (Alonso 2010); p index (GanganPrathap, 2010); mapping techniques (Karpagam et al. 2011). In this study new derived method known as Chelvan and Gopal method of measures of reach of scientific output was made using Reach percentage (RP); Reach Activity Index (RAI); Unreached/Reach Activity Index (URAI);Unreached Activity Index (UAI) and Richness Factor (RF) factors of authorship pattern has been used. These measurement tools were importance given to two factors known as age of the publication and the number of authors. (Tamizhchelvan and Gopalakrishnan, 2018a,b)

REVIEW OF RELATED LITERATURE

For bibliometric or scientometric method is common research tool to apply scientific production and identify the research trend studies in any subject including science and engineering (Almind & Ingwersen, 1997; Cronin, 2001; Moed, Debruin, & Vanleeuwen, 1995). Scientometric are very popularly adapted techniques in various disciples' stimulated and stupendous growth of literature and its related subject areas.

The conventional and traditional scientometric methods evaluate the research paper publications trend by investigating the research publication outputs of from different countries (Rahman, Haque, & Fukui, 2005), research institutes (Rajendram, Lewison, & Preedy, 2006), journals (Dannenberg et al, 1985), subjects (Rajendran , Ramesh Babu , & Gopalakrishnan , 2005) and research fields (Davis & Gonzalez, 2003 , Krishnamoorthy, Ramakrishnan, & Devi, 2009).

Studies related to citations of papers and authors, and especially of highly cited ones, always attract a lot of attention (VanNoorden, Maher, & Nuzzo, 2014), one reason being that citations act as indicators in individual and institutional evaluations (Persson, 2010; Leydesdorff, 2012; Abramo, Cicero, & D'Angelo, 2014; Bornmann, 2014). Citations, moreover, reflect relations in the network of scientific communications (Cronin, 1984).

METHODOLOGY

This study adopted new method of measurement of indexing methods with the data collected from the Scopus abstracting and citation database. In order to test the index method suggested, an attempt has been made to take up the research publications of similar nature on a particular domain governed by the policy maker. Reputed 20 management institutions of similar nature namely Indian Institute of Management, governed by the Government of India, spread across the country has been taken for the study. The publications of these institutions were considered since from the inception of the institutions.

OBJECTIVES OF THE STUDY

This study introduces a new method of measuring the research publications citation methods. There is few measurement of indexing methods for the publications. The following are citations of publications explained in two different methods namely measure of Reach and Richness.

- Reach Activity Index
- Unreach/Reach Activity Index
- Unreach Activity Index
- Richness Factor
    - for a paper
    - for an organization
    - for a year
    - for an author

MEASURE OF REACH AND RICHNESS

The scientific research output primarily depends on the reach of the paper and richness of the paper. Even there were many methods adopted, in this paper the method suggested by Chelvan and Gopal has been adopted **(Tamizhchelvan and Gopalakrishnan 2018a, 2018b)**

Measure of Reach

Chelvan and Gopal formula for **Measure of Reach,** as stated below, has been used in this study**.**

Measures of reach of scientific output were made using Reach Percentage (RP); Reach Activity Index (RAI); Unreached/Reach Activity Index (URAI) and Unreached Activity Index (UAI). The method of calculation was as follows

1. **Reach % = Reach output of Institution/ Total output of the institution . . . (1)**
2. **Reach Activity index**

The formula reads as follows:

$$\text{RAI} = \frac{R_{ij}/T_{io}}{R_{oj}/Too} \; X \; 100 \quad \ldots (2)$$

Where, R_{ij}= Number of cited publications for the particular Institutions a particular country

T_{io}= Total publications for the particular Institution

R_{oj}= Total cited publications of all the Institutions

T_{oo} = Total output of all the Institutions

3. **URAI = Unreach/Reach Activity Index**

The formula reads as follows:

$$\text{URAI} = \frac{R_{ij}/U_{io}}{R_{oj}/Uoo} \; X \; 100 \quad \ldots (3)$$

Where, R_{ij}= Number of cited publications for the particular Institution / a particular country

U_{io}= Total unreached publications for the particular Institution

R_{oj}= Total reach / cited publications of all the Institutions

U_{oo} = Total Unreach / uncited of all the Institutions

4. **UAI = Unreach Activity Index**

The formula reads as follows:

$$\text{UAI} = \frac{U_{ij}/T_{io}}{U_{oj}/Too} \; X \; 100 \ldots (4)$$

Where, U_{ij}= Number of Unreached / uncited publications for the particular Institution / a particular country

T_{io}= Total publications for the particular Institution

U_{oj}= Total unreached / uncited publications of all the Institutions

T_{oo} = Total publications of all the Institutions

Richness Factor (RF)

Chelvan and Gopal formula for Richness Factor (RF) , stated below, has been used in this analysis.

Richness Factor (RF) = No. of citations/no. of authors*age of the paper

The RF factor can be

- for a paper
- for an organization
- for a year
- for an author

1. **Richness Factor for a paper**

$$RF_{Paper} = \frac{Cit_{paper}}{Tot_{author} * AoP} \quad \ldots. (5)$$

where RF_{Paper} = Richness Factor of paper
Cit_{Paper} = No. of Citations of a paper
Tot_{author} = Total No. of authors of a paper
AoP = Age of a paper

Age of a paper can be calculated as follows

AoP = (Base year of the study – Paper published year) + 1

Eg. Let Base year may be 2018

Paper publication year may be 2017

Therefore AoP = (2018-2017) + 1 = 1+1 = 2

2. **Richness Factor for an Organization**

$$RF_{Org} = \frac{Cit_{Org}}{Tot_{author} * NoP} \quad \ldots. (6)$$

where RF_{Org} = Richness Factor for an organisation
Cit_{Org} = No. of Citations of an organisation
Tot_{author} = Total No. of authors of a paper
NoP = Number of papers

3. **Richness Factor for a year**

$$RF_{Year} = \frac{Cit_{Year}}{} \quad \ldots. (7)$$

$$\text{Tot}_{\text{author}} * \text{AoP}$$

where RF_{Year} = Richness Factor of year

Cit_{Year} = No. of Citations of a Year

Tot_{author} = Total No. of authors of a year

AoP = Age of a year

4. Richness Factor of an author

$$RF_{author} = \frac{Cit_{author}}{Tot_{paper} * Tot_{authors} * PoP} \quad \ldots. (8)$$

where RF_{author} = Richness Factor of an author

Cit_{author} = Total Citations of an author

Tot_{paper} = Total No. of paper by an author

Tot_{author} = Total No. of collaborated authors

PoP = Period of Publish

Period of Publish can be calculated as follows

PoP = (Last paper published year – First published Paper year) + 1

Eg. Let First published the paper year 2002

Last published Paper year may be 2018

Therefore AoP = (2018-2002) + 1 = 16+1 = 17

IIM INSTITUTIONS

After Independence of India, Jawaharlal Nehru, the then Prime Minister of India, initiated the establishment of IIMs, based on the recommendation of the Planning Commission of India. All the IIMs are registered as societies under the Indian Societies Registration Act. All the IIM has been given independent control over its routine activities and other operations in the institution. However, the main and administration of all IIMs and the overall strategy of IIMs are taken by the IIM council. Under the MHRD, The IIM Council is headed by the senior officials from Minister of Human Resource Development for the chairpersons and directors of all IIMs.

Among the 20 IIMs, 6 of them were established in 2015; in this study, the publications 13 IIMs are available in the Scopus only taken for this study.

OVERVIEW OF IIMS PUBLICATIONS

Out of 20 IIMs, 6 of them were established in 2015 and one established in 2016. Therefore 13 IIMs faculty research paper publications were taken up for the study. The data were collected from the Scopus database. 5755 publications were identified from 1965 to 2018.

Table 1 Overview of IIMs Publications

S.No.	Description	No. of papers	%
Authorship pattern			
1	Single	1560	27.11%
2	Two	2123	36.89%
3	Three	1254	21.79%
4	Four	476	8.27%
5	Five	171	2.97%
6	Six &above	171	2.97%
Citation			
1	Cited papers	**3625**	**63.0%**
2	Uncited papers	**2130**	**37.0%**
Research pattern			
1	Solo	1560	27.11%
2	Collaborated	4195	72.89%
Block Years			
1	1965-1973	35	0.61%
2	1974-1982	88	1.53%
3	1983-1991	147	2.55%
4	1992-2000	411	7.14%
5	2001-2009	1228	21.34%
6	2010-2018	3846	66.83%
	Total publications	**5755**	
Citation analysis			
1	Total citations	43234	
2	Total cited papers author	9534	
3	Average citation	11.93	

	per paper		
4	Average author for cited papers	2.63	

Among the total papers 5755, 63 per cent of papers of 3625 were cited whereas 2130 papers (37.0%) were not cited. It concluded that 63% of IIM's research publications reached users. Among the total papers 575, 72 per cent of papers 4195 collaborated papers. The solo research papers identified as 1560 records from the database, 882 (56.54%) papers were cited publications. Similarly out of 4195 collaborated papers, 2743 (65.39%) were reached publications. Out of 5755 publications, 1560 (27.11%) papers were solo research where as 4195 (72.89%) of papers collaborative in nature. 66.83% of publications were published during the block period of 2010-2018. It is followed by 1228 (21.34%) papers during the block period of 2001-2009. In all, nearly 89% of publications were published during the period 2001 and 2018. Only 3625 (63%) of papers were cited and has received a total citation of 43234 which has been contributed together by 9534 authors. The average citation per paper calculated to 11.93 per paper. Further, the contribution of 13 IIMs was analysed based on total papers published, reached papers, unreached papers, total authors, total citation, solo research, collaborated research and top author of the institutions.

The highest publications from each IIM has been presented in the table 2 with Total papers, reached, unreached, citations and collaboration with the top author name.

Table 2 Publications Details Individual IIMs

S.No.	IIMs	Total Papers	Reached Papers	Unreached papers	Total authors Reached papers	Total citation	Solo research	Collaborated research	Top author
1	IIM-A	1542	999	543	2916	13852	489	1053	Shukla, P.R.
2	IIM-B	1119	725	394	2127	9847	302	817	Gosh, P
3	IIM-C	1246	836	410	2136	10698	283	963	Mukerjee R.
4	IIM-I	350	178	172	370	1654	102	248	Dey S.
5	IIM-Kashipur	75	35	40	73	165	20	55	Batra S.

6	IIM-K	366	236	130	523	1873	78	288	Balooni K.
7	IIM-L	499	314	185	647	3265	159	340	Ali J.
8	IIM-Raipur	148	74	74	238	449	13	135	Gupta S.
9	IIM-R	62	26	36	58	95	5	57	Bala P.K.
10	IIM-Rohtak	172	117	55	228	811	70	102	Khare A.
11	IIM-S	66	40	26	108	268	14	52	Roychoudhury B.
12	IIM-T	44	18	26	40	136	12	32	Godwin T.
13	IIM-U	66	27	39	70	121	13	53	Roy S.
Total		**5755**	**3625**	**2130**	**9534**	**43234**	**1560**	**4195**	

The overall publications, about two-third of the publications have been reached the targeted users by way of citing them and remaining yet to reach. The overall trends for collaboration of authors are two authors per publications. In an average, there are 7 citations per paper for reached publications.

The institutions wise RAI, URAI and UAI were calculated as stated above formula and presented in Table 3.

Table 3 IIM Reached publications – Individual IIMs

S.No.	IIMs	Total Papers	Reached Papers	Unreached papers	Total authors Reached papers	Total citation	RAI	URAI	UAI	RF Index
1	IIM-A	1542	999	543	2916	13852	1.03	1.08	0.95	0.003
2	IIM-B	1119	725	394	2127	9847	1.03	1.08	0.95	0.004
3	IIM-C	1246	836	410	2136	10698	1.07	1.20	0.89	0.004
4	IIM-I	350	178	172	370	1654	0.81	0.61	1.33	0.013
5	IIM-Kashipur	75	35	40	73	165	0.74	0.51	1.44	0.030
6	IIM-K	366	236	130	523	1873	1.02	1.07	0.96	0.010
7	IIM-L	499	314	185	647	3265	1.00	1.00	1.00	0.010
8	IIM-Raipur	148	74	74	238	449	0.79	0.59	1.35	0.013
9	IIM-R	62	26	36	58	95	0.67	0.42	1.57	0.026
10	IIM-Rohtak	172	117	55	228	811	1.08	1.25	0.86	0.021

11	IIM-S	66	40	26	108	268	0.96	0.90	1.06	0.038
12	IIM-T	44	18	26	40	136	0.65	0.41	1.60	0.077
13	IIM-U	66	27	39	70	121	0.65	0.41	1.60	0.026
Total		**5755**	**3625**	**2130**	**9534**	**43234**	**1.00**	**1.00**	**1.00**	

It is observed from the table IIM Rohtak has highest value on RAI and URAI and lowest in UAI, and it is indicated that IIM Rahtak has performed well and the otherwise the lowest values are from IIM –T and IIM-U. RF is concerned the IIM-T is high, and IIM-A is very low.

The overall authorship pattern of IIM research publications was identified. The authorship pattern has been calculated from Single author to up-to Six and above categories.

Table 4 Authorship pattern of IIM Reached publications - Overall

S.No.	Authorship pattern	Reached		Unreached		Total	
		Papers	%	Papers	%	Papers	%
1	Single	882	56.5%	678	43.5%	1560	27.11%
2	Two	1377	64.9%	746	35.1%	2123	36.89%
3	Three	815	65.0%	439	35.0%	1254	21.79%
4	Four	321	67.4%	155	32.6%	476	8.27%
5	Five	110	64.3%	61	35.7%	171	2.97%
6	Six &above	120	70.2%	51	29.8%	171	2.97%
Total		**3625**	**63.0%**	**2130**	**37.0%**	**5755**	**100.0%**

More than one-fourth of the publications are from single author and more than one-third of the publications are from two authors. Among the reached publications 56.5% of single author publications reached the targeted users and same way, two-third of the publications from two authors.

Reach Activity Index versus Authorship pattern of individual IIMs has been calculated and presented in the table 5. Further RAI were calculated based on the formula stated above.

Table 5 RAI Vs Authorship pattern of Individual IIMs

S.No.	IIMs	Single	RAI	Two	RAI	Three	RAI	Four	RAI	Five	RAI	Six & above	RAI	Total
1	IIM-A	257	1.06	374	0.99	202	0.90	77	0.87	31	1.02	58	1.75	**999**
2	IIM-B	178	1.01	243	0.88	177	1.09	73	1.14	18	0.82	36	1.50	**725**
3	IIM-C	167	0.82	329	1.04	187	0.99	94	1.27	41	1.62	18	0.65	**836**
4	IIM-I	49	1.13	86	1.27	28	0.70	12	0.76	2	0.37	1	0.17	**178**
5	IIM-Kashipur	10	1.17	15	1.13	7	0.89	3	0.97	0	0.00	0	0.00	**35**
6	IIM-K	52	0.91	107	1.19	62	1.17	11	0.53	3	0.42	1	0.13	**236**
7	IIM-L	99	1.30	125	1.05	71	1.01	13	0.47	5	0.52	1	0.10	**314**
8	IIM-Raipur	4	0.22	16	0.57	24	1.44	22	3.36	6	2.67	2	0.82	**74**
9	IIM-R	3	0.47	16	1.62	5	0.86	2	0.87	0	0.00	0	0.00	**26**
10	IIM-Rohtak	52	1.83	38	0.86	16	0.61	6	0.58	3	0.84	2	0.52	**117**
11	IIM-S	4	0.41	12	0.79	18	2.00	5	1.41	0	0.00	1	0.76	**40**
12	IIM-T	3	0.68	9	1.32	5	1.24	1	0.63	0	0.00	0	0.00	**18**
13	IIM-U	4	0.61	7	0.68	13	2.14	2	0.84	1	1.22	0	0.00	**27**
Total		**882**	**1.00**	**1377**	**1.00**	**815**	**1.00**	**321**	**1.00**	**110**	**1.00**	**120**	**1.00**	**3625**

(RAI - Reach Activity Index)

It is observed from the table; there are six single author's IIM publications RAI values reached more than 1.00 and seven two authors' IIM publications RAI reached more than 1.00 values. Among the authorship collaboration, the three authors have been reached in good manner as seven IIMs publications with two IIMs secured RAI more than 2.00. Four authors and five authors publications from IIM-Raipur secured 3.36 and 2.67 respectively.

The authorship pattern with grouped RF index of these papers was analysed, and the same has been shown in Table 6

Table 6 Authorship pattern Vs Grouped RF Index – Overall

S.No.	Grouped RF Index	Single author	Two authors	Three authors	Four authors	Five authors	Six &above	Total
1	0.00 to 0.49	467	889	563	241	96	97	**2353**
2	0.50 to 0.99	167	268	145	42	9	11	**642**
3	1.00 to 1.49	109	88	52	17	0	4	**270**
4	1.50 to 1.99	44	46	23	10	3	6	**132**
5	2.00 to 2.49	33	25	14	3	1	1	**77**
6	2.50 to 2.99	13	17	5	3	0	0	**38**
7	3.00 to 3.49	10	13	4	1	0	1	**29**
8	3.50 to 3.99	9	4	2	0	0	0	**15**
9	4.00 & above	30	27	7	4	1	0	**69**
Total		**882**	**1377**	**815**	**321**	**110**	**120**	**3625**

Out of 69 papers that have richness factor more than four, 30 were single author publications, and the remaining were collaborative research. Out of 630 publications that have richness factor one and above, 248 papers were single author paper, and the remaining 382 were collaborative research. Normally other scientometric indexes show that collaborative research can categorise as high order paper. The index factor thus derived unbiased and be used for identifying the outreach paper. The RF index for individual authors who were contributed more papers was calculated, and the same has been shown in Table 7. The table also shows the rank based on citation and RF index calculated based on the derived formula.

Table 7 RF Index for Individual Authors

S.No	Inst. Name	Author name	Total Citations	Rank based on citation	No. of papers	Total no. Authors	First paper Year	Last paper Year	Age of paper	RF Index	Rank based on RF Index
1	IIM-A	Shukla, P.R.	1472	1	69	254	1992	2018	**27**	0.003	12
2	IIM-B	Gosh, P	369	3	39	126	2010	2018	**9**	0.008	7
3	IIM-C	Mukerjee R.	995	2	124	270	1990	2018	**29**	0.001	13

4	IIM-I	Dey S.	81	8	18	41	2010	2018	**9**	0.012	3
5	IIM-KASHIPUR	Batra S.	26	10	12	28	2015	2018	**4**	0.019	2
6	IIM-K	Balooni K.	168	7	20	54	2000	2018	**19**	0.008	8
7	IIM-L	Ali J.	179	6	31	52	2007	2016	**10**	0.011	5
8	IIM-RAIPUR	Gupta S.	218	5	30	105	2013	2018	**6**	0.012	4
9	IIM-R	Bala P.K.	6	12	9	20	2013	2017	**5**	0.007	11
10	IIM-ROHTAK	Khare A.	290	4	45	96	2011	2017	**7**	0.010	6
11	IIM-S	Roychoudhury B.	34	9	8	23	2010	2018	**9**	0.021	1
12	IIM-T	Godwin T.	4	13	7	15	2013	2017	**5**	0.008	10
13	IIM-U	Roy S.	13	11	12	27	2014	2018	**5**	0.008	9

Shukla P R has the highest number of citations i.e. 1472 citations for his 69 papers and ranked as first. It is followed by Mukerjee R (124 papers with 995 citations); Gosh P (39 papers with 369 citations) and Khare A (45 papers with 290 citations. The richness of their publications was identified using RF index based on the formula derived and the same has been shown in Table 7. Accordingly, the above three authors were ranked 12, 13 and seven respectively. According to RF index, the contribution of Roy choudhury B, who has eight papers with 34 citations was ranked first. It is followed by Batra S. (12 papers, 26 citations); Dey (18 papers, 81 citations) and Gupta, S (30 papers with 218 citations).

HIGH RF INDEX PUBLICATIONS:

High Richness factor index for publications paper was calculated, and the same has been shown in Table 8

Forty papers have RF index more than five. Out of 40 papers, five papers from IIM-A; four papers from IIM-B; 13 from IIM-C; five from IIM-I; three from IIM-K; six from IIM-L and four from IIM-ROHTAK. Out of forty, 20 were a solo research paper, and 20 were collaborated paper. Out of 20 solo research papers four from IIM-A; one from IIM-B, five from IIM-C; one each from IIM-I and IIM-K; four from IIM-L and four from IIM-ROHTAK.

Table 8 High Reach Factors (RF) Publications

S.No.	NoA	Authors	Year	Source title	Volume	Issue	Citation	IIMs	AOP	RF Index
1	1	Network design for reverse logistics / Srivastava S.K.	2008	Omega	36	4	300	IIM-L	11	27.27
2	2	Women as policy makers: Evidence from a randomized policy experiment in India / Chattopadhyay R., Duflo E.	2004	Econometrica	72	5	497	IIM-C	15	16.57
3	2	Pervasive computing: A paradigm for the 21st century / Saha D., Mukherjee A.	2003	Computer	36	3	407	IIM-C	16	12.72
4	2	A network algorithm for performing fisherâ€™s exact test in r Ã— c contingency tables / Mehta C.R., Patel N.R.	1983	Journal of the American Statistical Association	78	382	806	IIM-A	36	11.19
5	1	Pruning strategies for mining high utility itemsets / Krishnamoorthy S.	2015	Expert Systems with Applications	42	5	44	IIM-A	4	11.00
6	1	Performance evaluation and a flow allocation decision model for a sustainable supply chain of an apparel industry / Jakhar S.K.	2015	Journal of Cleaner Production	87	1	40	IIM-Rohtak	4	10.00
7	1	Revisiting the supplier selection problem: An integrated approach for group decision support / Kar A.K.	2014	Expert Systems with Applications	41	6	50	IIM-Rohtak	5	10.00
8	1	Revenue management for remanufactured products / Mitra S.	2007	Omega	35	5	118	IIM-C	12	9.83
9	1	Supply chain coordination using revenue-dependent	2013	Omega (United Kingdom)	41	4	59	IIM-I	6	9.83

		revenue sharing contracts / Palsule-Desai O.D.								
10	2	Supply chain analysis under green sensitive consumer demand and cost sharing contract / Ghosh D., Shah J.	2015	International Journal of Production Economics	164		76	IIM-C	4	9.50
11	2	Harnessing the influence of social proof in online shopping: The effect of electronic word of mouth on sales of digital microproducts / Amblee N., Bui T.	2011	International Journal of Electronic Commerce	16	2	133	IIM-K	8	8.31
12	1	The effect of country-of-origin on foreign brand names in the Indian market / Kinra N.	2006	Marketing Intelligence and Planning	24	1	107	IIM-L	13	8.23
13	2	A comparative analysis of greening policies across supply chain structures / Ghosh D., Shah J.	2012	International Journal of Production Economics	135	2	110	IIM-B	7	7.86
14	2	Managing a big data project: The case of Ramco cements limited / Dutta D., Bose I.	2015	International Journal of Production Economics	165		61	IIM-C	4	7.63
15	2	Unemployment and the real wage: The economic basis for contesting political ideologies / Bhaduri A., Marglin S.	1990	Cambridge Journal of Economics	14	4	432	IIM-C	29	7.45
16	3	Managing cross-cultural issues in global software outsourcing / Krishna S., Sahay S., Walsham G.	2004	Communications of the ACM	47	4	330	IIM-B	15	7.33
17	2	Agri-fresh produce supply chain management: A state-of-the-art literature review / Shukla M., Jharkharia S.	2013	International Journal of Operations and Production Management	33	2	88	IIM-K	6	7.33

18	2	Adoption of green supply chain management practices and their impact on performance: An exploratory study of Indian manufacturing firms / Mitra S., Datta P.P.	2014	International Journal of Production Research	52	7	73	IIM-C	5	7.30
19	1	Linguistic features for review helpfulness prediction / Krishnamoorthy S.	2015	Expert Systems with Applications	42	7	27	IIM-A	4	6.75
20	2	Green supply chains: A perspective from an emerging economy / Jayaram J., Avittathur B.	2015	International Journal of Production Economics	164		54	IIM-C	4	6.75
21	1	Inventory management in a two-echelon closed-loop supply chain with correlated demands and returns / Mitra S.	2012	Computers and Industrial Engineering	62	4	46	IIM-C	7	6.57
22	4	The role of gender stereotypes in perceptions of entrepreneurs and intentions to become an entrepreneur / Gupta V.K., Turban D.B., Wasti S.A., Sikdar A.	2009	Entrepreneurship: Theory and Practice	33	2	262	IIM-I	10	6.55
23	2	Sustainable supply chain management: Review and research opportunities / Gupta S., Palsule-Desai O.D.	2011	IIMB Management Review	23	4	101	IIM-I	8	6.31
24	1	Knowledge management and intellectual capital - The new virtuous reality of competitiveness / Rastogi P.N.	2000	Human Systems Management	19	1	118	IIM-L	19	6.21
25	1	Trade in health services/ Chanda R.	2002	Bulletin of the World Health Organization	80	2	103	IIM-B	17	6.06

26	1	Individual spirituality, workplace spirituality and work attitudes: An empirical test of direct and interaction effects / Pawar B.S.	2009	Leadership and Organization Development Journal	30	8	60	IIM-K	10	6.00
27	1	Analysis of a two-echelon inventory system with returns / Mitra S.	2009	Omega	37	1	58	IIM-C	10	5.80
28	1	Consumers' susceptibility to interpersonal influence as a determining factor of ecologically conscious behavior / Khare A.	2014	Marketing Intelligence and Planning	32	1	29	IIM-Rohtak	5	5.80
29	1	Neighborhood search heuristics for the uncapacitated facility location problem / Ghosh D.	2003	European Journal of Operational Research	150	1	92	IIM-A	16	5.75
30	1	Models to explore remanufacturing as a competitive strategy under duopoly / Mitra S.	2016	Omega (United Kingdom)	59		17	IIM-C	3	5.67
31	1	Innovations for the poor by the poor / Gupta A.K.	2012	International Journal of Technological Learning, Innovation and Development	5	1-Feb	39	IIM-A	7	5.57
32	2	The antecedents and consequents of user perceptions in information technology adoption / Agarwal R., Prasad J.	1998	Decision Support Systems	22	1	233	IIM-C	21	5.55
33	1	Service quality and customers' purchase intentions: An empirical study of the Indian banking sector / Choudhury K.	2013	International Journal of Bank Marketing	31	7	33	IIM-C	6	5.50

34	2	A systematic approach to conducting review studies: An assessment of content analysis in 25 years of IB research / Gaur A., Kumar M.	2018	Journal of World Business	53	2	11	IIM-I	1	5.50
35	2	Consumer decision-making across modern and traditional channels: E-commerce, m-commerce, in-store / Maity M., Dass M.	2014	Decision Support Systems	61	1	55	IIM-L	5	5.50
36	1	Antecedents to green buying behaviour: A study on consumers in an emerging economy / Khare A.	2015	Marketing Intelligence and Planning	33	3	22	IIM-Rohtak	4	5.50
37	2	Defining 'success' for software projects: An exploratory revelation / Agarwal N., Rathod U.	2006	International Journal of Project Management	24	4	142	IIM-I	13	5.46
38	1	The diffusion of mobile phones in India / Singh S.K.	2008	Telecommunications Policy	32	9-Oct	59	IIM-L	11	5.36
39	2	Managing product returns for reverse logistics / Srivastava S.K., Srivastava R.K.	2006	International Journal of Physical Distribution and Logistics Management	36	7	136	IIM-L	13	5.23
40	3	Foreign and domestic ownership, business groups, and firm performance: Evidence from a large emerging market / Douma S., George R., Kabir R.	2006	Strategic Management Journal	27	7	203	IIM-B	13	5.21

COMPARISON OF RF INDEX RANK AND CITATION RANK

The top forty publications of RF values have more than 5 taken for comparison with Citation rank. The RF Index for these papers were calculated and ranks were assigned based on RF index. Both RF index rank and Citation ranks were compared and the same has been shown in Table 9

Table 9 RF Index Vs Citation

S.No.	RF Index	RF Index Rank	Citation	Citation Rank
1	27.27	1	300	6
2	16.57	2	497	2
3	12.72	3	407	4
4	11.19	4	806	1
5	11.00	5	44	32
6	10.00	6	40	33
7	10.00	7	50	30
8	9.83	8	118	13
9	9.83	9	59	25
10	9.50	10	76	21
11	8.31	11	133	12
12	8.23	12	107	16
13	7.86	13	110	15
14	7.63	14	61	23
15	7.45	15	432	3
16	7.33	16	330	5
17	7.33	17	88	20
18	7.30	18	73	22
19	6.75	19	27	37
20	6.75	20	54	29
21	6.57	21	46	31
22	6.55	22	262	7
23	6.31	23	101	18
24	6.21	24	118	14
25	6.06	25	103	17
26	6.00	26	60	24
27	5.80	27	58	27
28	5.80	28	29	36
29	5.75	29	92	19

30	5.67	30	17	39
31	5.57	31	39	34
32	5.55	32	233	8
33	5.50	33	33	35
34	5.50	34	11	40
35	5.50	35	55	28
36	5.50	36	22	38
37	5.46	37	142	10
38	5.36	38	59	26
39	5.23	39	136	11
40	5.21	40	203	9

From this table, it is observed that there exist difference in ranking between Richness Factor Index based rank and Citation based rank. It shows that the value of Richness index, depends on age of the paper along with citation.

- Richness Factor is calculated on Age of the paper and Citations.
- The value of Richness Factor varies every year if citation value is not increased. This is directly inversely proposed to the RF Value.
- Age of the paper is considered for the Richness Value.
- Citation rank is only increase the number.

The factors thus given due importance were shown below

Factors	**Richness Factor**	**Citation Rank**
Age of the paper	Considered	Not considered
Citation	Considered	Considered
No. of authors	Considered	Not considered

The prime factor thus considered for richness factor were age of the paper besides citation and number of authors of a paper, where as citation rank methods the age of the paper has not been given due importance.

CONCLUSION

Reach of the paper has been identified based on the number of citations with other factors such as number of authors and the age of the publications. Four formulae each were identified by Chelvan and Gopal formula for (a) Measuring the reach of the publications and (b) Richness Factor (RF) has been employed. It observed that the factors that have been identified that attributed for reach and richness of publications seems to be meaningful instead of taking citation alone has criteria to predict the value of the paper. These measurement tools have been developed in view of covering all the factors in the bibliometric variables and their values. These tools will definitely march towards the highly preferred tools for measuring the publications values of researchers, institutions and so on.

REFERENCES

Abramo, Glovanni and D'Angelo, Ciriaco Andrea (2014). How do you define and measure research productivity?, *Scientometrics,* 101(2): 1129-1144.

Almind, Tomas C. & Ingwersen, Peter. (1997). Informetric analyses on the world wide web: Methodological approaches to 'webometrics'. Journal of Documentation. 53: 404-426.

Alonso, S., Cabrerizo, F., Herrera-Viedma, E. and Herrara, F. (2010). "hgindex: a new index to characterize the scientific output of researchers based on the h and g indices", *Scientometrics*, 82: 391-400.

Bornmann, L. (2014). How are excellent (highly cited) papers defined in bibliometrics? A quantitative analysis of the literature. Research Evaluation, 23(2):166-173.

Callon, M. (1986). The Sociology of an Actor-Network: The Case of the Electric Vehicle. In: Mapping the Dynamics of Science and Technology, edited by M. Callon, J. Law, A. Rip. Macmillian, London.

Callon, M.N., Courtiaol, J.P.N. & Laville, F.N. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry, *Scientometrics*, 22(1): 155-205.

Cronin, B. (1984). The Citation Process. *The Role and Significance of Citations in Scientific Communication*, 103p. Taylor Graham, Oxford.

Cronin, B. (2001). Hyperauthorship: a postmodern perversion or evidence of a structural shift in scholarly communication practices?, Journal of the American Society for Information Science and Technology Banner, 52(7) : 558-569.

Dannenberg, A.L. et al. (1985). Use of epidemiology in medical specialties: An examination by citation analysis. American Journal of Epidemiology, 121 (1): 140–151.

Devis, J.C & Gonzalez, J.G. (2003). Scholarly Journal Article about the Asian Tiger Economics Authors : Journal and research fields 1986-2001 - *Asian Pacific Economic Literature*, 17(2): 15-61.

Egghe, L. (2006). Theory and practice of the g-index, *Scientometrics*, 69(1): 131-152.

Gangan Prathap, Rekha Mittal. (2010). A performance index approach to library collection, Performance Measurement and Metrics, 11(3): 259-265.

He, Q. (1999). 'Knowledge discovery through co-word analysis. *Library Trends*, 48: 133-159.

Hirsch, J.E. (2005). An index to quantify an individual's scientific research output (available at http://arxiv.org/PS_cache/physics/pdf/ 0508/ 0508-25v5.pdf), 2005.

Javed, M (2008). Rawal Medical Journal – An Analysis of Citation Pattern. *Rawal Medical Journal*, 33(2): 254-257.

Jin, B.H. (2006). "H index: an evaluation indicator proposed by scientist", *Science Focus*, 1(1): 8-9.

Jin, B.H., Liang, L., Rousseau, R. and Egghe, L. (2007a). The R- and AR-indices: Complementing the h-index, *Chinese Science Bulletin*, 52(6): 855-863.

Jin, B.H. (2007b). The AR-index: complementing the h-index. ISSI Newsletter, 3(1).

Karpagam, R. (2014). Global research output of nanobiotechnology research: a Scientometircs study.*Current Science*, 106(1490), 89: 1490-1499.

Karpagam, R., Gopalakrishnan, S., Natarajan, M. and Babu Ramesh, B. (2011). Mapping of nanoscience and nanotechnology research in India: a scientometric analysis, 1990–2009. *Scientometrics*, 89: 501–522.

Kosmulski, M. (2006). "I" - a bibliometric index. Forum Akademickie, 11: 31

Krishnamoorthy G., Ramakrishnan, J. & Devi (2009). Bibliometric analysis of literature on diabetes (1995-2004), *Annals of Library and Information Studies*, 56: 150-155.

Leydesdorff (1997). 'The Triple Helix as a Model for Innovation Studies : Conference Report, *Science & Public Policy*, 25(3): 195-203. http://www.leydesdorff.net/th2/spp.htm (accessed on 15-10-2018).

Leydesdorff, L. (2012). Alternatives to the journal impact factor: I3 and the top-10% (or top-25%?) of the most highly cited papers. Scientometrics, 92: 355-365.

Moed, H.F., De Bruin, R.E. & Van Leeuwen, T.N. (1995). New bibliometric tools for the assessment of national research performance: Database description, overview of indicators and first applications, Scientometrics 33 (3) : 38-422.

Persson, Olle (2010). Are highly cited paper are international? Scientometrics, Scientometrics 83(2): 397-401.

Peter & Van Raan (1993). 'For Your Citations Only'?, Hot Topics in Bibliometric Analysis.

Prathap Gangan (2011). "The fractional and harmonic p-indices for multiple authorship", *Scientometrics*, 86(2): 239-244.

Rahman, M., Haque, T.L., & Fukui, T. (2005). Research articles published in clinical radiology journals: Trend of contribution from different countries, *Academic Radiology*, 12(7): 825-829.

Rajendiran, P, Ramesh Babu B and Gopalakrishnan, S. (2005). Bibliometric Analysis of "Fiber Optics" literature. Annals of Library and Information Studies, 52 (3): 82-85.

Rajendram, R., Lewison, G., & Preedy, V. (2006). Worldwide alcohol-related research and the disease burden. *Alcohol and Alcoholism*, 41(1): 99-106.

Sidiropoulos, A., Katsaros, D. and Manolopoulos, Y. (2007). "Generalized hirsch h-index for disclosing latent facts in citation networks". *Scientometrics*, 72(2): 253–280.

Tamizhchelvan, M and Gopalakrishnan, S. (2018a) Measure the Reach of Scientific Publications: A Scientometric Study, International Journal of Research in Library Science, 4(2) (ISSN 2455 104X) http://www.ijrls.in/journal_category/issue-no-2-july-december-2018-volume-no-4/#

Tamizhchelvan, M and Gopalakrishnan, S (2018b). Measuring Richness of the Research Output: A Scientometric Method, *Journal of Advances in Library and Information Science*, 7(3) p. 212-226. http://jalis.in/pdf/7-3/Tamizhchelvan.pdf

Tamizhchelvan, M and Gopalakrishnan, S (2018c). Collaborated Trend of IIM Publications: A Scientometric Study in the International Conference on Emerging Trends in Librarianship: Role of Libraries in learning environment edited by Dr. K. Elavazhagan et al. organized by Indian Institute of Management Tiruchirappalli held on 10-12, December 2018, pp. 593-609. (ISBN: 978-81-929999-0-6)

Van Noorden R., Maher, B and Nuzzo, R (2014). The top 100 papers, Nature. 2014 Oct 30;514(7524):550-3.

Zhang, C.T. (2009). "The e-index, complementing the h-index for excess citations", PLoS ONE, e5429. doi:10.1371 /journal. pone. 0005429, 4(5).